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Sec. 1.2: Apply Order of Operations

When an expression contains more than one operation, students need to use the correct order of operations. The order of operations is based on a convention; as long as everyone follows that convention, everyone should end up with the same answer.

Many have traditionally used the acronym PEMDAS to remember the prescribed order of operations, while some have used a slight modification of that acronym.

P: Parentheses

E: Exponents

M: Multiplication

D: Division

A: Addition

S: Subtraction

This traditional acronym works fine as long as the student bears a couple things in mind:

(1) The 'P' in PEMDAS represents not only parentheses, but all grouping symbols. These could include, for example:

- Brackets
- Braces
- A fraction bar
- A radical (similar to an exponent, actually)

(2) Multiplication and Division are equivalent; apply them in the order in which they appear, working left to right. Likewise, Addition and Subtraction are equivalent; apply them in the order in which they appear, working left to right.

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As a result, one might more accurately represent PEMDAS as follows:

Parentheses (or other grouping symbol, working from the inside if a grouping symbol appears inside another grouping symbol)

Exponents

Multiplication OR Division, working from left to right

Addition OR Subtraction, working from left to right

Examples

Evaluate the expression:

1. $3(2) + 8$

2. $3 + 2(8)$

3. $4^2 - 2(3)$

4. $(5 - 2)^2 + 8 \div 2 - 4(6)$

5. $36 \div 3^2 * (2 + 4)$

6. $\frac{2(1+8)}{(6-3)3}$

7. Evaluate the expression $4x + 7$ when $x = 3$.

8. Evaluate the expression $\frac{1}{2}(3x^2 - 10)$ when $x = 4$.

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Practice Problems

Evaluate each expression:

1) $15 - 7 + 2$

2) $16 - 3^2$

3) $4 \cdot 5 - 2$

4) $6 \cdot 4^2 - 10$

5) $5^2 - 8 \div 2 \cdot 3$

6) $(18 + 14) \div 4$

7) $30 \div (6^2 - 2 \cdot 13)$

8) $4 - 3^2 \div (6^2 \div 2)$

9) $(4 - 21 \div 7)^3$

10) $(6 - 4)[(8 + 2)3]$

11) $\frac{1}{2}(7^2 - 3 \cdot 9)$

12) $\frac{1}{3}(2 \cdot 10 + 4^2)$

Evaluate the expression:

13) $6x + 4$ when $x = 2$

14) $y^2 - 20$ when $y = 3$

15) $5m^3 - 3m^2$ when $m = 2$

Describe AND correct the error in evaluating the expression.

16) $6^2 \div 3 \cdot 6 = 36 \div 3 \cdot 6 = 36 \div 18 = 2$

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Practice Problems

Evaluate each expression:		
1) $15 - 7 + 2$ $= 8 + 2$ $= 10$	2) $16 - 3^2$ $= 16 - 9$ $= 7$	3) $4 \cdot 5 - 2$ $= 20 - 2$ $= 18$
4) $6 \cdot 4^2 - 10$ $= 6 \cdot 16 - 10$ $= 96 - 10 = 86$	5) $5^2 - 8 \div 2 \cdot 3$ $= 25 - 8 \div 2 \cdot 3$ $= 25 - 4 \cdot 3$ $= 25 - 12 = 13$	6) $(18 + 14) \div 4$ $= 32 \div 4$ $= 8$
7) $30 \div (6^2 - 2 \cdot 13)$ $= 30 \div (36 - 2 \cdot 13)$ $= 30 \div (36 - 26)$ $= 30 \div 10 = 3$	8) $4 - 3^2 \div (6^2 \div 2)$ $= 4 - 3^2 \div (36 \div 2)$ $= 4 - 3^2 \div 18$ $= 4 - 9 \div 18 = 4 - \frac{1}{2} = 3\frac{1}{2}$	9) $(4 - 21 \div 7)^3$ $= (4 - 3)^3$ $= 1^3 = 1$
10) $(6 - 4)[(8 + 2)3]$ $= 2[10(3)]$ $= 2(30)$ $= 60$	11) $\frac{1}{2}(7^2 - 3 \cdot 9)$ $= \frac{1}{2}(49 - 3 \cdot 9)$ $= \frac{1}{2}(49 - 27)$ $= \frac{1}{2}(22) = 11$	12) $\frac{1}{3}(2 \cdot 10 + 4^2)$ $= \frac{1}{3}(2 \cdot 10 + 16)$ $= \frac{1}{3}(20 + 16)$ $= \frac{1}{3}(36) = 12$
Evaluate the expression:		
13) $6x + 4$ when $x = 2$ $= 6 \cdot 2 + 4$ $= 12 + 4 = 16$	14) $y^2 - 20$ when $y = 3$ $= 3^2 - 20$ $= 9 - 20 = -11$ <i>(Oops, sorry for the negative.)</i>	15) $5m^3 - 3m^2$ when $m = 2$ $= 5 \cdot 2^3 - 3 \cdot 2^2$ $= 5 \cdot 8 - 3 \cdot 4$ $= 40 - 12 = 28$
Describe AND correct the error in evaluating the expression.		
16) $6^2 \div 3 \cdot 6 = 36 \div 3 \cdot 6 = 36 \div 18 = 2$ The student performed the multiplication before the division, but the division is to the left of the multiplication and should therefore be done first. $6^2 \div 3 \cdot 6 = 36 \div 3 \cdot 6 = 12 \cdot 6 = 72$		